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ENEE 610 Fall 2002

Problems to consider #3

1. Determine which of the following are positive real and which are bounded real; give your reasons

a) F(S)= 0.5

b) $F(s)=\frac{2}{s+1}+\frac{3}{s-3}-\frac{5}{s+5}$

c) $F(s)=1_2+\frac{1}{s}\begin{bmatrix}2 & 1\\ 1 & 3\end{bmatrix}$

d) $F(s)=1_2+\frac{1}{s+8}\begin{bmatrix}1 & -1\\ -1 & 1\end{bmatrix}$

e) $F(s)=\sqrt{9(s+4)}$

f) $F(s)=\mathrm{ctanh}(9[s+4])$

2. Show that the following F(s) can be a lossless admittance and give four different syntheses as an admittance. Repeat if it is considered as an impedance. What if it is a scattering coefficient? Assuming it is an admittance find the corresponding scattering coefficient; find the poles and zeros and check that S(s)S(-s)=1.

$$F(s)=\frac{5s(s^2+9)(s^2+25)}{(s^2+1)(s^2+16)}$$

3. Consider the voltage out over voltage in transfer function

$$T(s)=\frac{10s}{(s+5)(s^2+5s+25)}$$

Give several means to realize this through a 2-port structure. Can it be realized by a resistor loaded RC 2-port? Check one of your realizations by setting up an indefinite matrix considering all internal nodes and then eliminating internal nodes.

4. Given real n-vectors x, y with the scalar product $<y,x>=y^{T*}x$ where * = complex conjugate (which can be ignored at this point), show that the following is a bounded real matrix. If this is a scattering matrix, if possible find the corresponding admittance Y_x. Give a circuit that realizes this S_x as a scatteromg matrix.

$$S_x=1_n-\frac{2}{<x.x>}xx^T$$

5. For S. of 4. above find $S=S_yS_x$ and show that this product of two scattering matrices is bounded real. Is it equal to S_{yx}?

6. Consider similar questions to 4. above for

$$S_{x,y}=1_n-\frac{2}{<x.y>}xy^T$$

6. For what f(s) is the following bounded real?

$$S_x(s)=1_n-2f(s)\frac{xx^T}{<x.x>}$$